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Solar Water Condensation Using Thermoelectric Coolers

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Abstract-*Water resources for irrigation can be difficult to obtain specially in the arid regions. However, for high humidity areas such as places close to the sea water can be condensed from the air.the project is an attempt to providing drinking water to the people where there is shortage of pure and fresh drinking water so that we can overcome the problem mentioned above. And the proposed solar powered thermoelectric air conditioning system is based on the principles of peltier effect to create a finite temperature difference across the condenser and the evaporator of the air conditioning system. Cold side of the thermoelectric module is used for air conditioning application provides cooling to the living space. The thermal energy from hot side of module is dumped to the surrounding environment. Consists of cooling element, heat exchange unit and air circulation unit. A solar cell panel unit with a relevant high current output drives the cooling elements though a controlling circuit.*

Keywords: *water condensation, irrigation, solar cell, thermoelectric, humidity sensor*

I. INTRODUCTION:

Thermoelectric cooler is devices when two different materials from a junction. When DC power is applied then the heat will flow form junction and resulting in one side form cooler and other side form warmer. Thermoelectric coolers Consist of a peltier element and heat sink combination to cool the thermoelectric cooler. Peltier elements come in different forms and shapes. Typically they consist of a bigger amount of thermocouple fixed in rectangular form and packaged between two thin ceramic plates. Thermoelectric coolers consist of heat pumps and these heat pumps solid state devices without moving parts gasses (or) fluids. The basic laws of thermodynamic apply to these devices as they do to conventional heat pump absorption refrigerators and another device involving the transfer of heat energy. An analogy commonly used to help comprehend thermoelectric cooling systems is that of standard thermocouple Uses to measure temperature. Thermoelectric cooling device have two sides of semiconductor one is n-type semiconductor and another side p-type semiconductor. Heat is absorb at the cold junction is send to the hot junction at a rate proportional to current passes through the circuit and number of couples. A conventional cooling system consist of three fundamental parts the condenser, heat sink and compressor. A thermoelectric cooling also some analogous parts. The heat is absorbed by electrons as they pass from a low energy level in the p-type element. The power supply provides the energy to move the electrons through the system. At the hot junction energy is expelled to a heat sink as electrons move from a high energy level element n-type semiconductor to a less energy level element p-type semiconductor.

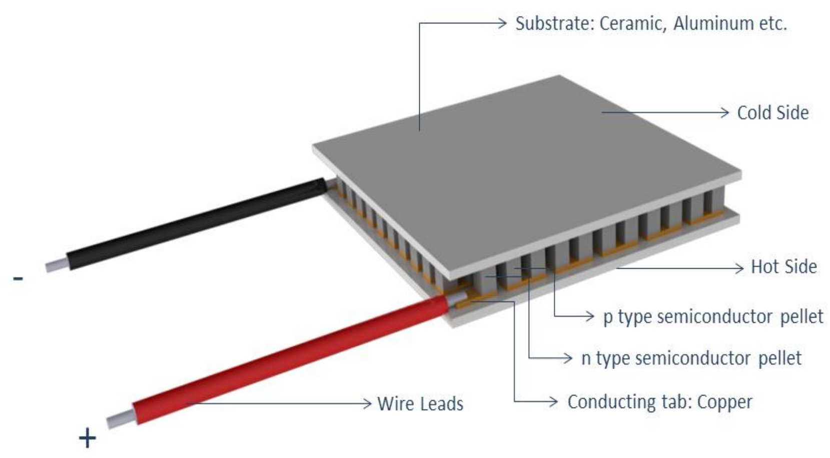


Fig.1: Thermoelectric cooler

II. Parameters required for devices selection:

In practically thermoelectric cooler couples are combined in a module jointed electrically in series and thermally in parallel to obtain a positive output. But it will be inconvenient to use such a device that has lower advantageous work done to power ration. Modules are available in the market according to variety of sizes, shapes, operating voltages currents and ranges of heat pumping capacity. The present trend, however, is towards a big number of couples operating at less current; before choosing an efficient device, some parameters must be determined.

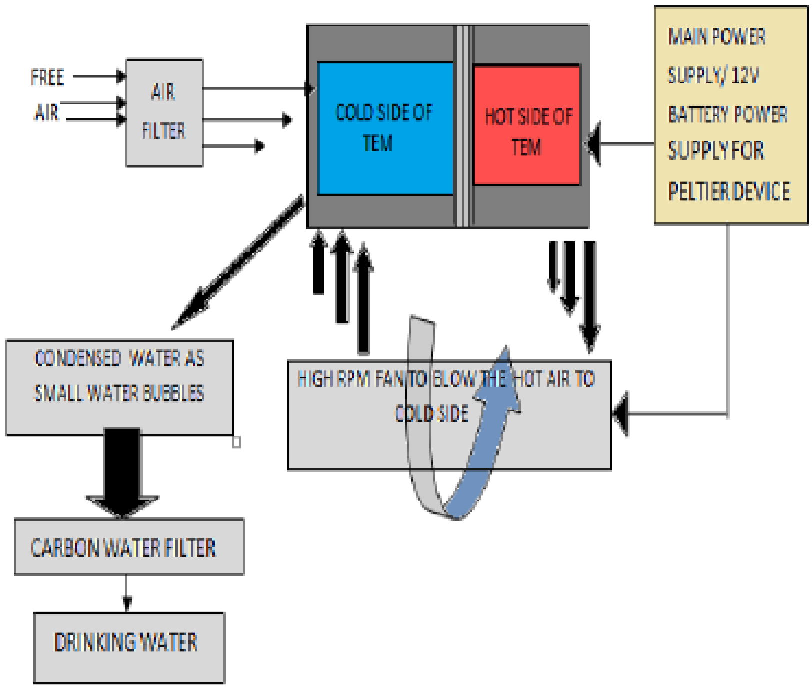
Tc: Temperature at Cold Surface.
TH: Temperature at Hot Surface.
This TH incorporates two major parameters:
1) The efficiency of the device i.e. between the hot surface of the TEC and the ambient environment.
2) The temperature of ambient environment into which the heat is being rejected.
QC: The heat to be absorbed at the Cold Surface.
The object to be cooled is intimately confined with the cold surface of TEC, thus the temperature of that object starts falling until it is as same as the temperature of the cold surface of the TEC.
Now ΔT can be defined as:
$\Delta T = TH - TC$
This conflict should be accurately determined if the design is to operate as desired.

III. Solar drive thermoelectric

Solar energy has the good advantage of less water consumption during its use-phase thus it ideal for installation in areas where there is a more degradation of freshwater supply. However uses of solar refrigeration would have been still excluded if the energy crisis in 1970s did not affect the modern thoughts research on Peltier’s cooling effect and Photovoltaic effect also developed around that time primarily for the cold chain project of the World Health Organization and the international Health Organizations specifically for rural areas. Solar cells were used inside small thermoelectric operated fridges. Experimental investigation and analysis on a solar cell driven thermoelectric refrigerator has been conducted. The main parts of the solar battery consist of cell including the Photo Voltaic array the storage battery and the controller. The photo voltaic array is installed at outdoors and the battery stores the more produced during sunshine periods. This stored energy is further used for running the system during the night times also. The controller is a important electronic device, assembled with microprocessor which can readily sense the battery condition as well as the power consumptions and controls the system operation accordingly. It has very simple circuit design. The main duty of it is to protect the battery against more charging or discharging. There are specially designed lead-acid batteries suitable for deep discharge cycles occurring in systems indeed this battery could be any type.

IV. working of the devices

The technique used in the assembly of a thermoelectric cooler system and humidity sensor is as important as the selection of the proper device. First we uses humidity sensor is used so that the condensation will start automatically if the required humidity level is reached and cut off when the humidity is less. And according to the previous elaboration, the objective is to calculate the dew point temperature Tdp from the gathered information about that ambient environment into which the device is going to run i.e. the information regarding Hr and Ta. Once the dew point temperature is obtained, the peltier coefficient P and the current rating of the device (TEC1-12706) can also be obtained from device data table; thus the estimated time for generating water droplets from the humid air is calculated readily. As soon as the device is powered the hot side starts getting hotter and cold side cooler; reaching the dew point temperature. The cold side of thermoelectric cooler starts to cool the air passing through its heat sink area and water vapours start to condense just like the water condensation happens outside a glass full of ice. It is important to keep in mind that when thermoelectric cooler starts it takes a longer time to actually produce water, though it reaches the dew point temperature readily, but after some time the process acquires the speed to produce sufficient water according to the experiment result of this project. TEC1 is a device that is used for average efficiency requirement according to the power is fed and time taking to reach its optimum level of cooling effect. As this project mainly lies on the uses of solar energy, it is immediately not possible to use higher TEC as those will require higher voltage rating. So comparatively it’s fruitful to use TECI-12706 through it takes a bit longer time to run efficiently.



V. RESULT AND DISCUSSSIONS

The solar cell unit used in this system has a 12 V rating output voltage with the maximum output power of 10 W, which is able to supply enough power for one 40 W Peltier coolers connected in parallel. Each Peltier cooler has a dimension of 4x4x0.8 cm, maximum current of 3.6 A and the maximum temperature difference □T of 75°C.The heat sink for each Peltier element is made of aluminum alloy and has a dimension of 15x15 cm making the total heat exchange area to be 45x15 cm on each side of the Peltier elements. The air is pumped into the system using a 300 psi, 12v Compressor. The moisture air is pumped first into the hot side of the Peltier element to increase the air temperature and in the same time to cool the hot side of the element. The capacity of air to hold water vapour varies according to the temperature of the air. The warmer the air, the more water-vapour it can hold. As the air cools down, its capacity to hold water will decrease. The air is then pushed to the cold side to condense the water moisture, as shown in Fig. 2. The condensed water falls into a reservoir to be used for irrigation.

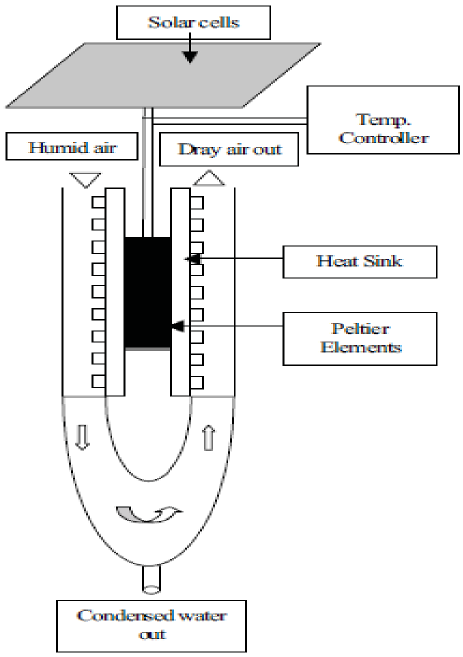


Fig.3: build water condensation

When testing an assembly of this type it is important to monitor temperature and relative humidity. Measuring the temperature and the humidity of the cooling inlet and outlet air as well as flow rates is necessary. Therefore a closed loop control unit was built using PIC16f872 microcontroller to control the system keeping the temperature of the circulating air below the water freezing point. A picture of the built system is shown in Figure 3. Applying this system in a high humidity region such as Yanbu produced almost 1 Liter of condensed water per hour during the day light which is a promising result for a more sophisticated system that encounter higher power solar cells and facility to store the excessive energy during the day light to be used at night, which we are currently working on.

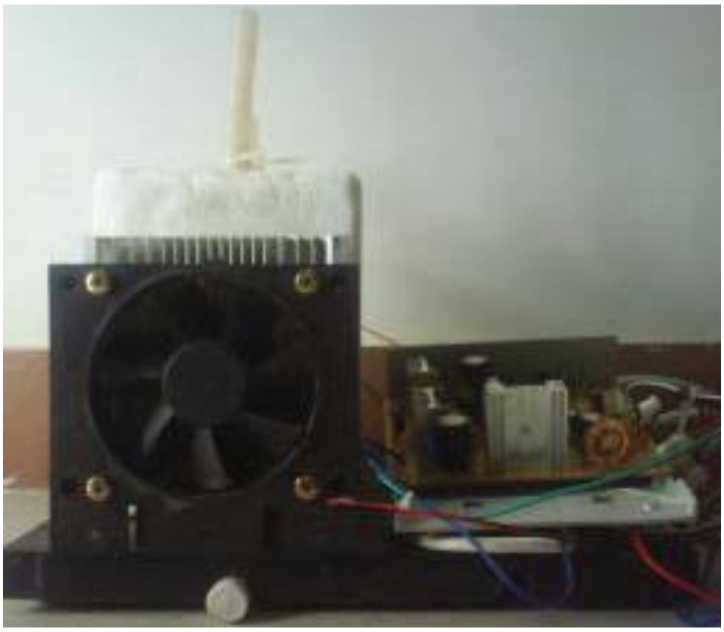


Fig. 3: A picture of the built water condensation system

V.CONCLUSIONS

A solar water condensation system is built using a thermoelectric cooler, solar panels, humidity sensor, heat exchange unit and an electronic control unit. The system is self powered and can be used in isolated and desert areas to condensate water from the surrounding humid air. And applying the system in high humidity see area produced 1L of water per hour which can be used mainly for irrigation. The economical advantage of this kind of system is still obscure due to the relatively high installation cost. This system would be a long term cost saving system since the energy source is free and the solar sub system generally requires small maintenance. The development and production of such equipment is a future business possibility.

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